

Hyperbaric Oxygen Therapy for Cesarean Section Wound in Diabetes Mellitus Gravida

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We report the use of hyperbaric oxygen (HBO) therapy to treat the complication of necrotizing fasciitis following Cesarean section in a postpartum gravida with diabetes mellitus. Our patient was a 25-year-old, gravida 1, para 1, woman with a history of type 1 diabetes mellitus since the age of 18. The patient experienced preterm labor at 31^{+1} gestational weeks and was treated with magnesium sulfate for tocolytic therapy. The patient then went into labor at 39^{+6} gestational weeks. She received Cesarean section due to prolonged labor associated with non-reassuring fetal status of both smooth baseline and fetal tachycardia. An ultrasound scan of the lower abdomen on the 4th postoperative day revealed fluid collection measuring 4 mm over the rectus fascia and edematous change of the surrounding soft tissues under the Cesarean section incision site. The patient eventually received HBO for a total of 7 days. Following HBO, the condition of the surgical wound improved dramatically. The results of this case showed that HBO has the potential to be a cost-effective way to enhance the healing of necrotizing fasciitis in diabetes mellitus gravida. [J Chin Med Assoc 2008;71(7):373-376]

Key Words: Cesarean section, diabetes mellitus gravida, hyperbaric oxygen therapy, necrotizing fasciitis

Introduction

Necrotizing fasciitis is a rare soft tissue infection, primarily involving the superficial fascia and commonly resulting in extensive involvement of the surrounding tissues.¹⁻³ It is generally believed that a continuous supply of oxygen to the necrotized tissue through the microcirculation is vital for healing and for protection against infection.⁴ One of the possible ways of improving tissue oxygenation is hyperbaric oxygen (HBO).⁴ It has been proven that HBO promotes angiogenesis and wound healing, kills certain anaerobes, prevents growth of bacteria such as *Pseudomonas*, prevents production of clostridial alpha-toxin, restores neutrophil-mediated bacterial killing in previously hypoxic tissues, and reduces leukocyte adhesion in reperfusion injury, preventing release of proteases and free radicals, which cause vasoconstriction and cellular damage.⁴

Based on experimental clinical observations, most of the national hyperbaric medicine societies have recommended the initiation of HBO therapy for wound

healing and for minimizing the infectious process for the treatment of necrotizing soft tissue infection. But there are few reports on the use of HBO in the field of obstetrics. Here, we report our experience with HBO therapy to treat the complication of necrotizing fasciitis after Cesarean section in a postpartum diabetes mellitus gravida.

Case Report

Our patient was a 25-year-old, gravida 1, para 1, woman with a history of type 1 diabetes mellitus since the age of 18, mild fatty liver and obesity. On physical examination, her fasting blood sugar level was 235 mg/dL and her postprandial sugar level was 336 mg/dL. Hemoglobin A1c was 12.7%, and ketone bodies were found in her blood. The patient had a history of failing to take oral hypoglycemic agents and was consequently given insulin therapy of around 48 U/day for treatment of type 1 diabetes.



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When she became pregnant, a uterine myoma measuring $42 \times 31 \times 37$ mm in size was found in her anterior uterine wall during routine prenatal check-up. During the pregnancy, her insulin was increased to a dosage of 68 U/day at 29^{+6} gestational weeks. The pregnancy course was complicated with an episode of preterm labor at 31^{+1} gestational weeks, which was successfully treated with magnesium sulfate for tocolytic therapy. The patient then went into labor at 39^{+6} gestational weeks, and underwent Cesarean section due to prolonged labor associated with non-reassuring fetal status of both smooth baseline and fetal tachycardia.

Following Cesarean section, the patient experienced moderate pain at the incision site and moderate-grade fever (38.2°C) associated with erythematous change with purulent bloody discharge at the wound site on the 4th postoperative day (Figure 1). The white blood cell count was $10,500/\text{mm}^3$, and C-reactive protein level was 1.07 mg/dL (reference range, $0\text{--}0.5 \text{ mg/dL}$). An ultrasound scan of the lower abdomen revealed edematous change of the incision wound and a fluid collection of 4 mm in depth over the rectus fascia was measured (Figure 2). The diagnosis of subcutaneous necrotizing fasciitis was made.⁵



Figure 1. Edematous, erythematous change of the skin, associated with necrotizing fasciitis, along the Pfannestiel incision before hyperbaric oxygen therapy began.

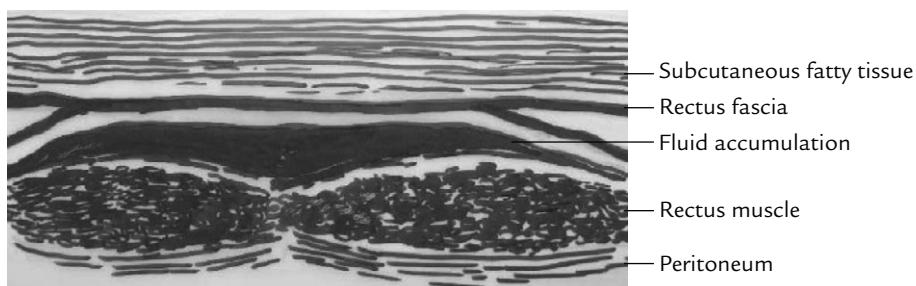


Figure 2. Depiction of the 2-dimensional ultrasound of the incisional wound complicated with acute fasciitis. There was fluid collection of 4 mm in depth above the rectus fascia.

The fluid collection was aspirated under sonar guidance and the culture was positive for penicillin-resistant *Staphylococcus aureus*.⁶ The patient was then given glycopeptide (teicoplanin) and extended-spectrum penicillin (Tazocin) according to culture sensitivity. A respiratory therapy consultant was called, and following that consultant's recommendation, we obtained Doppler scans of the lower limbs, which were normal, and measured the transcutaneous oxygen tension (TcPo_2) at the upper portion of the Pfannestiel incision, finding it to be $<40 \text{ mmHg}$.⁷

The patient received HBO in 1 90-minute daily session of 100% oxygen breathing in a multiplace hyperbaric chamber (Comex Pro, Comex, Marseille, France) pressurized at 2.5 ATA (absolute atmosphere air) on the 6th postoperative day. This regimen lasted 5 days a week for 2 consecutive weeks, in accordance with Méchine et al.⁸ The HBO sessions included a period of air compression in air for 15 minutes followed by 3 30-minute breathing periods, at a pressure of oxygen inhaled (Fio_2) = 1, separated by 5-minute intervals of air breathing (Fio_2 = 0.21) and then a decompression period of 15 minutes.⁷ HBO therapy was then given for a total of 7 days.

After HBO therapy, the condition of the surgical wound improved dramatically. The patient's body temperature returned to normal on the 3rd post-therapeutic day, and the edematous and erythematous appearance of the wound site completely resolved on the last therapeutic day. The 1-month follow-up of the surgical wound after completion of HBO therapy revealed no adverse changes at the wound site, and it had healed uneventfully. No wound debridement or open wound drainage was needed.

Discussion

Necrotizing fasciitis is a rare, often fulminant, rapidly progressive infectious process that primarily involves the fascia and subcutaneous tissue. The wide range of

therapeutic strategies for such wounds reflects the various pathologies that may cause tissue breakdown, including poor blood supply resulting in inadequate oxygenation of the wound bed. HBO therapy has been suggested to improve oxygen supply to wounds and therefore improve their healing.⁹ Patients with necrotizing fasciitis usually present with the triad of exquisite pain, swelling and fever. Tenderness, erythema, and warm skin are commonly the only signs of early disease.⁹ Distinction between uncomplicated infectious cellulitis or fasciitis, and necrotizing fasciitis is important. This condition is difficult to recognize in the early phase when it is often confused with cellulitis. Ultrasonography of the lesions demonstrated distorted, thickened fascia with fluid accumulation.³ The ultrasonographic diagnosis of necrotizing fasciitis is based on the criterion of diffuse thickening of the subcutaneous tissue accompanied by a layer of fluid accumulation of >4 mm in depth.³ Ultrasonography is also used as a guide for aspiration of pus. The choice of antibiotic therapy is made on the results of culture. In our case, the fluid accumulation was aspirated, but it had disappeared after HBO therapy. Surgical debridement and drainage was avoided. This case study provides evidence that HBO therapy increased the healing rate of necrotizing fasciitis in Pfannestiel incisional wound in diabetes mellitus gravida. It suggests the possibility of shortening hospitalization stay by more than 3 weeks in such patients.⁷

Oxygen is an essential component of wound healing, and the wound's ability to heal can be directly linked to the level of tissue oxygenation.¹⁰ Oxygen is used for protein synthesis, cell replication, hydroxylation of collagen, exportation of collagen out of the fibroblast cell, and neoepithelialization.¹⁰ The effectiveness of wound repair is directly related to oxygen concentration.¹⁰ Angiogenesis at the edges of the wound site is driven by the existing oxygen gradient⁸ between the oxygen-poor area in the center of the wound and the oxygen-rich area at the periphery of the wound.¹⁰ The oxygen-poor, lactate-rich environment in the center promotes macrophages to produce angiogenesis factors until capillary ingrowth is complete, while the periphery of the wound supplies the oxygen necessary to support the angiogenesis process. Furthermore, the leukocyte's ability to kill bacteria is based in part on its ability to produce free radicals, which is oxygen gradient-dependent.¹⁰ This gradient also affects the leukocyte's ability to clear bacteria from the wound site.¹⁰

Systemic HBO further increases tissue oxygenation. The treatment consists of placing the patient in a pressure chamber set at a pressure greater than 1 atmosphere and adjusting the surface breathing mixtures to

100% oxygen.⁶ Each gram of hemoglobin carries 1.34 mL of bound oxygen, while inhaled air only adds 0.3 mL of dissolved oxygen per 100 mL of blood. This means that someone with a hemoglobin level of 15 g/dL who is breathing normal air carries 20.1 mL of oxygen (15×1.34) via hemoglobin. S/he also carries 0.33 mL of dissolved oxygen in the surrounding plasma for a total of 20.4 mL per 100 mL. HBO further increases the amount of dissolved oxygen, so that each additional atmosphere of pure oxygen adds 2.2 mL of dissolved oxygen per 100 mL of blood (2.2 vol%).¹⁰

Measurement of the partial oxygen pressure of the tissue (P_{tO_2}) can be accomplished by introducing a small oxygen sensor into the tissue. Subcutaneous tissue is the first tissue to suffer from oxygen deprivation and the last to be normalized, for which reasons this tissue level is the optimal place for monitoring general tissue perfusion. Clinically, measurement of the blood saturation (pulse oximetry) is used routinely. This method, however, primarily reflects the oxygen conditions in the blood, and it only has value in situations where all factors that influence P_{tO_2} are functioning optimally.¹¹

What are the criteria that determine who will benefit from HBO therapy? Several studies measured whether patients' tissue oxygen level during HBO was predictive of response.¹² One study of 20 patients with chronic arterial insufficiency ulcer and diabetic ulcer reported that wound healing was achieved in all patients who were able to achieve a distal transcutaneous tissue oxygen level of at least 100 mmHg during HBO therapy.¹¹

The selection of patients for HBO should exclude those with contraindications, including emphysema, proliferating retinopathy and claustrophobia.¹⁰ There are risks associated with HBO therapy that are similar to diving disorders. Pressure changes can cause a "squeeze" or barotrauma in the tissues surrounding trapped air inside the body, such as the lungs, behind the eardrum, inside paranasal sinuses, or trapped underneath dental fillings. Breathing high-pressure oxygen for long periods can cause oxygen toxicity. Temporary blurred vision can be caused by swelling of the lens, which usually resolves in 2–4 weeks.⁹ Examination of the adverse events reported for all forms of HBO therapy revealed that oxygen toxicity in the form of seizures was observed in up to about 10% of patients in several studies.¹² One seizure-related death occurred in a "severely toxemic" patient who died 2 hours after an uncontrolled seizure.¹² A patient with pneumothorax was 1 among several deaths reported in a case series of 30 patients.¹² The pneumothorax was not reported to be the immediate cause of death in this patient. The need to provide emergency care during HBO treatment suggests that multiplace chambers may provide

a safer treatment modality, although this has not been demonstrated.¹²

In Taiwan, HBO therapy is not recognized by the Bureau of National Health Insurance. However, debridement and dressing changes for necrotizing fasciitis prolonged a 4-week admission for a diabetic gravida. The cost of the entire admission for the traditional therapy was more than NT\$56,000. Since an HBO therapy session of 7 days costs NT\$14,000, there would be a significant potential cost saving, amounting to NT\$42,000, by using adjunctive HBO therapy.

In conclusion, the results of this case report show that HBO has the potential to enhance healing of necrotizing fasciitis in diabetes mellitus gravida and is cost-effective. A large multicenter trial is needed to confirm the long-term, large-scale results.¹³

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